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AN APPROACH FOR DEALING WITH LARGE ERRORS

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ABSTRACT

Numerical functions or equivalent algorithms are commonly used to derive estimates for physical quantities that can be expressed in terms of more fundamental physical parameters. It is shown that in situations where large uncertainties (errors) are involved in these parameters, or where error amplification occurs through severe non-linearity of the functions, conventional deterministic techniques for calculating the derived quantities and estimating their errors can lead to erroneous results. Instead, it is necessary to resort to a probabilistic approach and thereby obtain estimates for mean values and variances of the derived quantities through Monte Carlo simulation in order to preserve the essential information without distortion. The correct choice for a probability distribution is suggested by the inherent nature of the random variable in question. Examples are given from the analysis of radioactivity decay, the shielding of penetrating radiation, and the derivation of nuclear reaction rates that are used in astrophysical calculations to model nucleosynthesis of the elements in stellar explosions. Subsequent analyses that use these derived quantities must also be carried out in a probabilistic manner to insure that the obtained results will reflect the underlying information properly.